



Health Consultation

DUANE MARINE

PERTH AMBOY, MIDDLESEX COUNTY, NEW JERSEY

EPA FACILITY ID: NJD054526553

JULY 28, 2003

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

DUANE MARINE

PERTH AMBOY, MIDDLESEX COUNTY, NEW JERSEY

EPA FACILITY ID: NJD054526553

Prepared by:

New Jersey Department of Health and Senior Services
Hazardous Site Health Evaluation Program
Consumer and Environmental Health Services
Division of Epidemiology, Environmental and Occupational Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Statement of Issues

The United States Environmental Protection Agency (USEPA) requested assistance from the Agency for Toxic Substances and Disease Registry (ATSDR) in determining whether the Duane Marine site, 26 Washington Street, Perth Amboy, Middlesex County, poses an immediate threat to the public health. In response to this request and through a cooperative agreement with the ATSDR, the New Jersey Department of Health and Senior Services (NJDHSS) prepared the following Health Consultation for the Duane Marine site. At the request of the USEPA, this Health Consultation is limited to potential exposures associated with analytical results of the most recent surface soil samples collected from the site.

Background

In the 1970's, Duane Marine operated as a waste oil collection, blending, and recycling facility, but soon after expanded its operation to include hazardous waste collection, processing, storage, transportation, treatment, and disposal. The site was abandoned subsequent to a 1980 fire which destroyed the facility; the site has now been condemned by the city of Perth Amboy. Presently, the city of Perth Amboy is considering the site and surrounding area for a large waterfront redevelopment project as part of an ongoing urban renewal initiative referred to as FOCUS 2000 (NJDEP 2001). The intent of the FOCUS 2000 redevelopment plan for the city of Perth Amboy is to transform hundreds of acres of abandoned, underused, and contaminated land into residential housing, commercial enterprises, and recreational facilities. FOCUS 2000 plans for the Duane Marine site include apartments, townhouses, a marina, and commercial businesses, including a restaurant.

According to the USEPA, Potentially Responsible Parties (PRPs) are willing to remediate the site to non-residential cleanup levels contingent upon the city and the developer financing the additional costs necessary to remediate to more stringent residential cleanup levels. Negotiations concerning the cleanup of the site are ongoing, and the site may eventually be listed on the National Priorities List (NPL) of Superfund sites.

Geographic Information System (GIS) spatial analysis technology, in conjunction with 2000 United States Census data, were used by the ATSDR to estimate that there are approximately 37,000 individuals residing within a one mile radius of the Duane Marine site (Figure 1). The water supply for the city of Perth Amboy is obtained from groundwater in the Runyon Wellfields in Old Bridge, New Jersey, about nine miles south of Perth Amboy (Utility Service Affiliates 2001). According to 1990 United States Census data, there are 59 reported private drinking water wells located in Perth Amboy.

Site Visit

On March 26, 2003, staff performed a site visit at the Duane Marine site. Present were Steven Miller and Julie Petix of the NJDHSS; Leah Escobar of the ATSDR; Joseph Cosentino, On-Scene Coordinator, and Richard Salkie, USEPA; and Gary Rojek, Middlesex County Public Health Department. The site visit commenced at 10:00 am. Weather conditions were sunny, some clouds, light breeze, with temperatures in the mid 60s. Odors were noticeable, described by those present as "sulfur," "diesel," "gasoline," "sewage," and "salt air." Although the seven acre site is fenced and posted as "Private Property" and "No Trespassing," the fence is dilapidated, entry gates are open, and the site is easily accessible. The site is bordered to the east by the Arthur Kill, a tidal strait connecting the Kill Van Kull and Newark Bay to the north with Raritan Bay and Raritan River to the south; Tri-State Ship Repair and Drydock Company (formerly Perth Amboy Dry Dock) to the south, a vacant lot previously owned by General Cable Corporation to the west; Gregory Metal Fabricators, Inc. to the northwest; and Vira Manufacturing, Inc. to the north. Several men were observed fishing in the Arthur Kill, and ducks were swimming along the coastline. Staten Island, New York and the Outer Bridge Crossing Bridge were observed across the Arthur Kill to the east and northeast of the site, respectively. The area surrounding the site includes heavy industry, residences, and commercial properties. Residences and several schools (Perth Amboy Catholic Intermediate School, grades 3-5; Anthony V. Ceres Elementary School, grades K-4) are within a few blocks of the site, and the new Middlesex County Vocational and Technical High School is currently under construction on reclaimed brownfields two blocks from the site.

The majority of the site is paved with either concrete or asphalt, although it is in considerable disrepair. There are gaping holes in the concrete and numerous physical hazards are present which include broken glass, rubble, and mounds of household trash. A fire-damaged, broken windowed, three-story brick building and an adjoining one-story brick building located on the site are used by trespassers for parties, as indicated by the numerous remaining alcoholic beverage cans and bottles. Along the unpaved shoreline, approximately six 5,000 gallon tanks, as well as one large 250,000 gallon tank remain on the site. The tanks were recently crushed after it was observed that homeless adults were using them as shelters. According to the USEPA, the transients are an adult population with no children. Elementary and intermediate school-aged children, however, reportedly use the site to ride bicycles on makeshift ramps; during the site visit, a youngster rode his bike onto the site, took what appeared to be a two-wheeled, upright cart out of a trash pile, and left. There are no hand washing or toilet facilities available at the site, and the USEPA has reportedly observed human excrement on the site.

Environmental Contamination

Surface Soil

The surface soil sample data provided by the USEPA were collected from two discrete soil sample locations along the Duane Marine site's shoreline and are referred to by the NJDHSS as the north and south sample locations. Minimum, maximum, and average concentrations for the analyzed substances are provided in Tables 1 and 2. Health screening values and NJDEP Residential Soil Cleanup Criteria are provided for comparison purposes. NJDEP Soil Cleanup Criteria are based upon human health impacts but also take into consideration environmental impacts.

Maximum surface soil concentrations for the north sample location included: 94 parts per million (ppm) polychlorinated biphenyls (PCBs); 43.1 ppm arsenic; 1,080 ppm cadmium; 10,000 ppm lead; and 53.1 ppm mercury (see Table 1). Maximum surface soil concentrations for the south sample location included: 75 ppm PCBs; 69.1 ppm arsenic; 41.9 ppm cadmium; 14,500 ppm lead; and 4.5 ppm mercury (see Table 2).

Discussion

Assessment Methodology

The general method for determining whether a public health hazard exists to a community is to evaluate the environmental and human components that lead to human exposure. An exposure pathway is the process by which an individual is exposed to contaminants from a source of contamination and consists of the following five elements:

- (1) source of contamination;
- (2) environmental media (e.g., air, groundwater, surface water, soil, sediment, biota);
- (3) point of exposure (i.e., location of potential or actual human contact with a contaminated medium);
- (4) route of exposure (e.g., inhalation, dermal contact/absorption, ingestion); and
- (5) receptor population.

Exposure pathways are further classified into three groups: (1) "completed pathways," i.e., those in which exposure is reasonably likely to have occurred, to occur, or to occur in the future; (2) "potential pathways," i.e., those in which exposure might have occurred, may be occurring, or may yet occur; and, (3) "eliminated pathways," i.e., those that can be eliminated from further analysis because one of the five elements is missing and will never be present, or in which no contaminants of concern can be identified.

After an exposure pathway is designated as completed, potential, or eliminated, a two-step methodology is followed to evaluate public health issues related to exposure pathways at hazardous

waste sites. First, representative environmental monitoring data is obtained for the site of concern and a list is compiled of site-related contaminants. Contaminant levels are compared to established health screening values. For substances that exceed established health screening values, site-specific conditions are evaluated to determine likely exposure scenarios for a given exposure pathway. Given this exposure scenario, a dose is estimated and compared with scientific studies to determine whether the extent of exposure indicates a public health hazard.

Exposure Pathways

There is a completed exposure pathway from surface soil to homeless adults living on the Duane Marine site and elementary and intermediate school-aged children who trespass on the site. Other potential exposure pathways were not evaluated as part of the Health Consultation.

Contaminants of Concern

Health screening values are considered conservative because they include ample safety factors that account for most sensitive populations. If, however, a contaminant is found at levels greater than its health screening value, the pollutant is designated as a contaminant of concern to be examined further in the assessment. Since health screening values are based on conservative (i.e., protective) assumptions, the presence of contaminant concentrations greater than a health screening value does not necessarily mean that adverse health effects will occur among the exposed population.

Contaminants selected for further evaluation of potential health effects at the Duane Marine site included PCBs, arsenic, cadmium, lead, and mercury (see Tables 1 and 2). Using the following equation for non-cancer health effects,

$$\text{Exposure Dose} = \frac{C \times IR \times EF}{BW}$$

where C = milligrams of contaminant per kilogram of soil

IR = intake rate of soil (assumed ingestion rate for adults is 100 milligrams/day)

BW = body weight (in kilograms)

EF = exposure factor

exposure factor =

$$\frac{(\text{number of days of exposure per year} \times \text{the number of years of exposure})}{(\text{days per year} \times \text{number of years exposed})}$$

and the next equation for cancer health effects,

$$\text{Exposure Dose} = \frac{C \times IR \times EF}{BW}$$

where C = milligrams of contaminant per kilogram of soil
 IR = intake rate of soil (assumed ingestion rate for adults is 100 milligrams/day)
 BW = body weight (in kilograms)
 EF = exposure factor

exposure factor =

(number of days of exposure per year x the number of years of exposure)
 (days per year x 70 years)

site-specific doses were calculated for a 70 kilogram (kg) adult using minimum, maximum, and average soil contaminant concentrations from the location with the higher set of values (see Appendix A). Exposure dose assumptions are reiterated in Appendix A. Estimated exposure doses calculated for non-cancer health effects for each substance were then compared to their respective Minimal Risk Level (MRL), when available. The MRL is an estimate of the exposure level at which adverse (excluding cancer) health effects are not expected to occur in non-hypersensitive individuals. MRLs are based largely on toxicological studies in animals and on reports of human occupational (workplace) exposures. Exposure to a level above the MRL does not mean that adverse health effects will occur. The ATSDR derives MRLs using quantitative and qualitative information for many potential systemic, neurological, and developmental effects. MRLs are specific for the route and the duration of exposure. Cancer risk methodology constitutes exposure dose (calculated for cancer health effects) multiplied by the cancer slope as determined by the USEPA. Cancer risk was considered "excess" if it exceeded one in 10,000. Results are summarized as follows:

Non-Cancer and Cancer Risks Based Upon Estimated Exposure Doses		
Substance	MRL Exceeded for Non-Cancer Adverse Effects	Lifetime Excess Cancer Risk >1 in 10,000
PCBs	yes (maximum concentration) yes (average concentration)	no
Arsenic	no	no
Cadmium	yes (maximum concentration) yes (average concentration)	not applicable
Lead	no MRL available	not applicable
Mercury	no	not applicable

For both PCBs and cadmium, the estimated exposure doses for non-cancer health effects is an order of magnitude above the MRL at the maximum concentrations detected at the site (PCBs = 94 ppm; cadmium = 1,080 ppm). At the average concentration of PCBs (22.69 ppm) and cadmium (292.63 ppm) detected at the site, the estimated exposure doses for non-cancer health effects is slightly above

the MRL. At these levels near the MRL, health effects would not be expected to occur. The average rather than the maximum concentration may be more representative of chronic (≥ 365 days) exposures. No apparent non-cancer adverse effects or excess cancer risks were found at the calculated exposure doses for arsenic and mercury.

Although there is no MRL available for lead, there are health guidelines and methods for evaluating body burdens based upon soil contaminant levels.

Lead

Environmental exposure to lead has long been recognized as a public health problem particularly among children. Excessive concentration of lead in soil has been shown to increase lead levels in children, and blood lead concentration has been generally accepted as the best measure of the external dose of lead in both children and adults (ATSDR 1999 and Madhavan et al 1988).

The ATSDR has developed an approach to estimate blood lead levels from environmental lead concentrations utilizing regression analysis with multi-route uptake parameters (ATSDR 1999). This approach applies slope values from selected studies to integrate total exposure from various pathways (i.e., air, soil, dust, water, and food), providing a cumulative exposure estimate expressed as total blood lead. Using a modified version of this equation which focuses strictly on soil exposure, a blood lead increment was predicted for children (less than 18 years of age) playing on the site and homeless adults living on the site (see Appendix B). For a child spending 25 percent of his or her play time on the site, a blood lead increment of 7 to 25 micrograms per deciliter (ug/dl) was estimated based upon the average (4,140 ppm) and maximum (14,500 ppm) soil lead concentrations detected on the site; for homeless adults living on the site, a blood lead increment of 4 to 14.5 ug/dl was estimated. No documentation exists on the percent of play time a child actually spends at the site, so there is uncertainty about the accuracy of the assumption and estimates. Because there are no hand washing or toilet facilities available at the site, the use of the assumed soil ingestion rate of 100 mg/day may be an underestimate for the homeless adult population living on the site.

Public Health Implications

According to the Centers for Disease Control and Prevention (CDC), a blood lead level above 10 ug/dl is of concern for children, and 50 ug/dl is the federal occupational standard for worker removal from exposures (OSHA 1993). The blood lead increments predicted for children and homeless adults at the Duane Marine site are cause for concern, particularly among the children. Some of the health effects of lead exposure on various organ systems are permanent or latent and may appear after exposure has ceased. Signs and symptoms associated with lead toxicity include decreased learning and memory, lowered Intelligence Quotient (IQ), speech and hearing impairment, fatigue, and lethargy.

Prominent physiologic effects and symptoms are neurologic, renal, hematologic, and cardiovascular (hypertension). Maternal blood lead can cross the placenta and put the fetus at risk

(e.g., low birth weight, premature birth). Evidence for carcinogenicity of inorganic lead and elemental lead is insufficient to determine human carcinogenicity. The USEPA Science Advisory Board has recommended that lead be considered a probable human carcinogen (ATSDR Case Studies in Environmental Medicine 2000).

Children's Health Considerations

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults. They also play outdoors and often bring food into contaminated areas. They are shorter than adults, which means they breathe dust, soil, and heavy vapors closer to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Children less than six years of age who are particularly vulnerable to the toxic effects of lead are not likely to have access to the Duane Marine site. Elementary and intermediate school-aged children (ages seven through 11 or 12), however, have been reported by the USEPA to access the site to ride their bicycles. This is a health concern particularly at the high levels of lead detected in on-site surface soil.

Conclusions

The NJDHSS and the ATSDR categorize the Duane Marine site as a ***"Public Health Hazard."*** Surface soil samples obtained along the shoreline of the site were found to have high concentrations of PCBs and metals (arsenic, cadmium, lead, and mercury). There is a completed exposure pathway to homeless adults living on the site, and elementary and intermediate school-aged children who regularly trespass on the site to play. Using a modified statistical approach in estimating blood levels from environmental lead concentrations, it was estimated that children spending 25 percent of their play time on the site would add approximately 7 to 25 ug/dl of lead to their blood; a blood lead increment of 4 to 14.5 ug/dl was estimated for homeless adults living on the site. Some health problems associated with lead toxicity include decreased learning and memory, lowered Intelligence Quotient (IQ), speech and hearing impairment, hypertension, reproductive disorders, fatigue, and lethargy.

This determination was based upon the analytical results of the most recent surface soil samples collected from the site under current site conditions. These data are limited and may not characterize the full extent of contamination present at the site or the maximum potential for contaminant exposures. Additionally, other exposure pathways associated with the site may exist.

Recommendations

1. Access to the site should be immediately restricted in order to disrupt the exposure pathway associated with contaminated soil.
2. Local social services organizations should be contacted and informed of the situation at the Duane Marine site. Outreach to the homeless adult population living on the site should include explaining potential health risks associated with living on the site and alternative housing programs that are available.
3. Although average concentrations of PCBs and cadmium detected at the site were slightly above the MRL, they were an order of magnitude above the MRL at the maximum concentrations measured. Since only a small number of samples were considered for this Health Consultation, it is prudent to obtain additional samples in order to validate the assumption that the average rather than maximum concentrations are more representative of site conditions.

Public Health Action Plan

The Public Health Action Plan (PHAP) for the Duane Marine site contains a description of the actions to be taken by the NJDHSS and/or ATSDR at or in the vicinity of the site subsequent to the completion of this Health Consultation. The purpose of the PHAP is to ensure that this Health Consultation not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the NJDHSS and ATSDR to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by NJDHSS and ATSDR are as follows:

Public Health Actions Taken

1. Current surface soil data for the Duane Marine site have been reviewed and evaluated to determine human exposure pathways and public health issues.

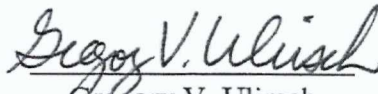
Public Health Actions Planned

1. A copy of the Public Health Consultation will be provided to local health officials along with a request that issues relating to the homeless adult population living on the site be investigated.
2. Educational outreach should be implemented to area physicians, particularly pediatricians and primary care physicians, regarding elevated blood lead levels. Topics should include common symptoms of lead toxicity. Findings of this report should also be made available to the local childhood lead poisoning prevention program.

3. When results of recommended additional soil sampling are available, health implications associated with potential exposures to PCBs and cadmium will be reevaluated.
4. The USEPA will request that the property owner for the Duane Marine site and the City of Perth Amboy coordinate efforts to restrict access to the site.

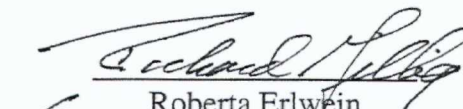
Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services (NJDHSS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It has been produced in accordance with approved methodology and procedures existing at the time the health consultation was begun.


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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.


for Roberta Erlwein
Chief, SPS, SSAB, DHAC
ATSDR

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Duane Marine

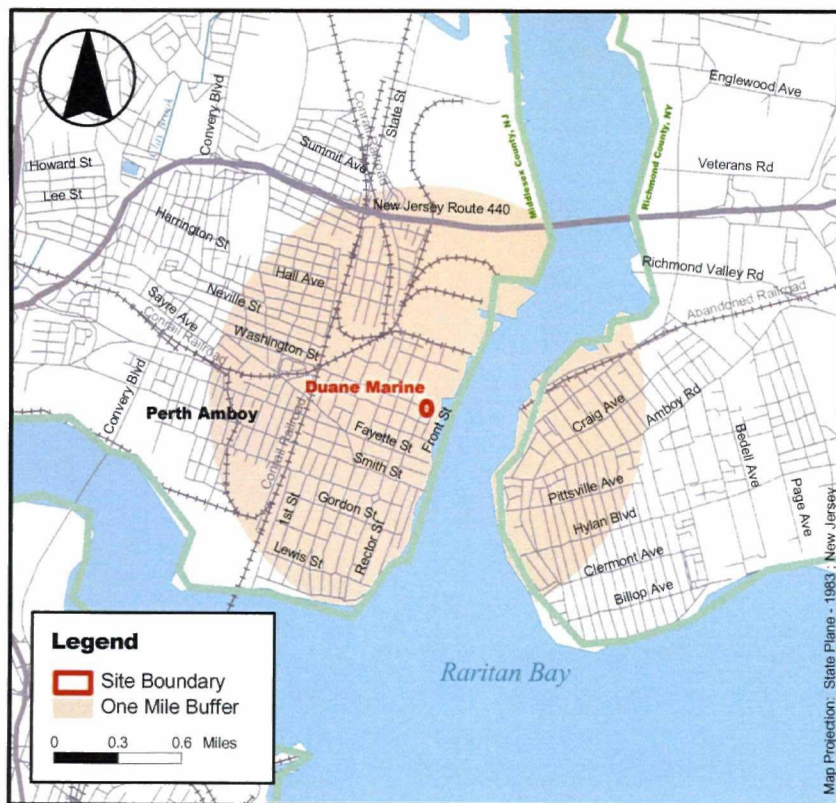
Perth Amboy, New Jersey

EPA Facility ID NJD054526553

INTRO MAP



Middlesex County, New Jersey



Base Map Source: 1995 TIGER/Line Files

Demographic Statistics Within Area of Concern*

Total Population	36785
White alone	18675
Black alone	3096
Am. Indian and Alaska Native alone	266
Asian alone	551
Native Hawaiian and Other Pacific Islander alone	45
Some other race alone	12147
Two or More races	2002
Hispanic or Latino	24067
Children Aged 6 and Younger	4233
Adults Aged 65 and Older	3273
Females Aged 15 - 44	8656
Total Housing Units	11605

Demographics Statistics Source: 2000 US Census

*Calculated using an area-proportion spatial analysis technique

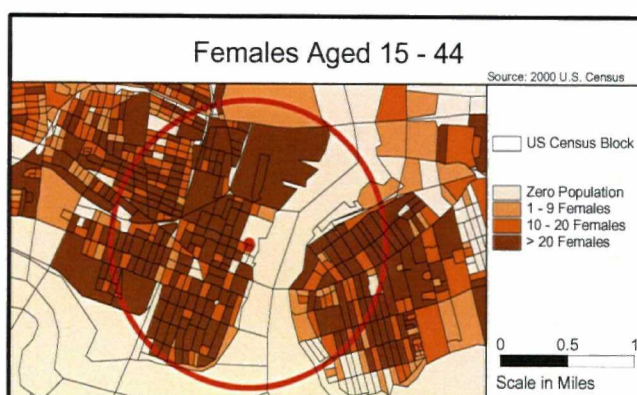
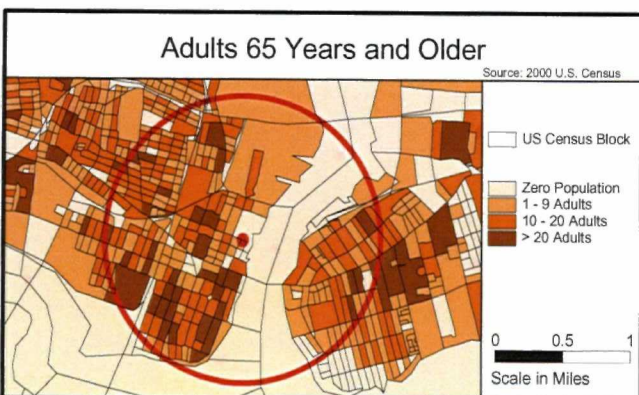
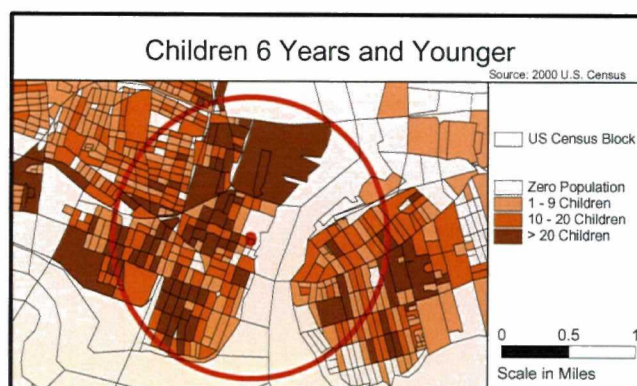
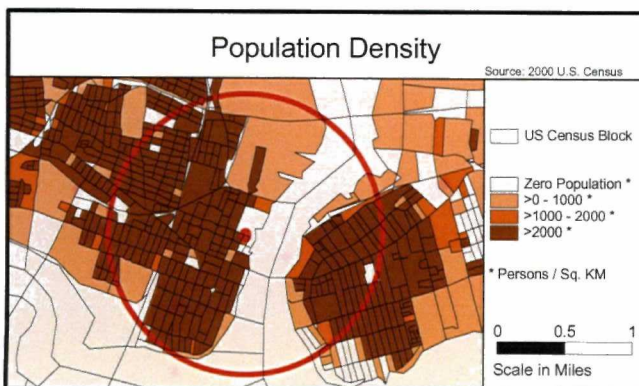


Table 1
Duane Marine Site, Perth Amboy, Middlesex County
North Sample Location: Surface Soil (0 - 6 inches depth)

Substance	# Samples Analyzed	Minimum Concentration Detected (ppm)	Maximum Concentration Detected (ppm)	Average Concentration Detected (ppm)	Health Screening Value (ppm)	NJDEP Residential Cleanup Criteria (ppm)	Selected for Further Evaluation of Potential Health Effects
PCBs	9	0.062	94	23	0.4 (CREG)	0.49	YES
Arsenic	9	11.6	43.1	22	0.5 (CREG) 0.43 RBC (C)	20	YES
Barium	9	86.2 J	502 J	218	5,500 RBC (N)	700	NO
Cadmium	9	15.1	1,080	293	39 RBC (N)	39	YES
Chromium (total)	9	30.6	154 J	70 J	230 RBC (N)	240 ¹	NO
Lead	9	1,000	10,000	2,660 (median = 1,700)		400	YES
Mercury (inorganic)	9	0.95	53.1	11.4	23 RBC (N) ²	14	YES
Silver	9	1.3 B	12.5	5.5	390 RBC (N)	110	NO

¹NJDEP Residential Clean-up Criteria for hexavalent chromium based on inhalation exposure pathway

²RBC provided is for the substance mercuric chloride

RBC = USEPA Region III Risk-based Concentration for residential soils; (C) = carcinogenic effects, (N) = non-carcinogenic effects

CREG = ATSDR Cancer Risk Evaluation Guide for 1E-06 (one in a million) excess cancer risk

J = estimated

B = above method detection limit but below required contract detection limit

Table 2
Duane Marine Site, Perth Amboy, Middlesex County
South Sample Location: Surface Soil (0 - 6 inches depth)

Substance	# Samples Analyzed	Minimum Concentration Detected (ppm)	Maximum Concentration Detected (ppm)	Average Concentration Detected (ppm)	Health Screening Value (ppm)	NJDEP Residential Cleanup Criteria (ppm)	Selected for Further Evaluation of Potential Health Effects
PCBs	10	7.9	75	38	0.4 (CREG)	0.49	YES
Arsenic	10	7.2	69.1	29	0.5 (CREG) 0.43 RBC (C)	20	YES
Barium	10	117 J	1,710 J	563 J	5,500 RBC (N)	700	NO
Cadmium	10	0.94	41.9	6.3 (median = 2.05)	39 RBC (N)	39	YES
Chromium (total)	10	17.6 J	138 J	62 J	230 RBC (N)	240 ¹	NO
Lead	10	1,150	14,500	4,140 (median = 1,820)		400	YES
Mercury (inorganic)	10	0.59	4.5	1.7	23 RBC (N) ²	14	YES
Silver	10	0.37	3.7	2.1	390 RBC (N)	110	NO

¹NJDEP Residential Clean-up Criteria for hexavalent chromium based on inhalation exposure pathway

²RBC provided is for the substance mercuric chloride

RBC = USEPA Region III Risk-based Concentration for residential soils; (C) = carcinogenic effects, (N) = non-carcinogenic effects

CREG = ATSDR Cancer Risk Evaluation Guide for 1E-06 (one in a million) excess cancer risk

J = estimated

B = above method detection limit but below required contract detection limit

Appendix A

PCBs: Exposure Dose Calculations for Non-Cancer and Cancer Health Effects
North Sample Location: Duane Marine Site, Perth Amboy, Middlesex County

Assumption: north sample location, adult (70 kg), exposure duration (365 days per year for 10 years), exposure frequency (daily)
soil ingestion (100 mg/day) for homeless adults, PCBs = Aroclor 1254

Substance	Minimum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
PCBs	0.062	100	70	8.86E-08	2.00E-05	365	10	2	1.27E-08	2.53E-08

Substance	Maximum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
PCBs	94	100	70	1.34E-04	2.00E-05	365	10	2	1.92E-05	3.84E-05

Substance	Average Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
PCBs	22.69	100	70	3.24E-05	2.00E-05	365	10	2	4.63E-06	9.26E-06

Arsenic: Exposure Dose Calculations for Non-Cancer and Cancer Health Effects

South Sample Location: Duane Marine Site, Perth Amboy, Middlesex County

Assumption: south sample location, adult (70 kg), exposure duration (365 days per year for 10 years), exposure frequency (daily) soil ingestion (100 mg/day) for homeless adults

Substance	Minimum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
arsenic	7.2	100	70	1.03E-05	3.00E-04	365	10	1.5	1.47E-06	2.20E-06

Substance	Maximum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
arsenic	69.1	100	70	9.87E-05	3.00E-04	365	10	1.5	1.41E-05	2.12E-05

Substance	Average Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
arsenic	28.88	100	70	4.13E-05	3.00E-04	365	10	1.5	5.89E-06	8.84E-06

Cadmium: Exposure Dose Calculations for Non-Cancer and Cancer Health Effects
North Sample Location: Duane Marine Site, Perth Amboy, Middlesex County

Assumption: north sample location, adult (70 kg), exposure duration (365 days per year for 10 years), exposure frequency (daily)
soil ingestion (100 mg/day) for homeless adults

Substance	Minimum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
cadmium	15.1	100	70	2.16E-05	2.00E-04	365	10		3.08E-06	0

Substance	Maximum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
cadmium	1,080	100	70	1.54E-03	2.00E-04	365	10		2.20E-04	0

Substance	Average Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
cadmium	292.63	100	70	4.18E-04	2.00E-04	365	10		5.97E-05	0

note: USEPA Region III RBC table lists only cadmium water, cadmium food

Lead: Exposure Dose Calculations for Non-Cancer and Cancer Health Effects
South Sample Location: Duane Marine Site, Perth Amboy, Middlesex County

Assumption: south sample location, adult (70 kg), exposure duration (365 days per year for 10 years), exposure frequency (daily)
soil ingestion (100 mg/day) for homeless adults

Substance	Minimum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
lead	1,150	100	70	1.64E-03		365	10		2.35E-04	0

Substance	Maximum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
lead	14,500	100	70	2.07E-02		365	10		2.96E-03	0

Substance	Average Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
lead	4,136	100	70	5.91E-03		365	10		8.44E-04	0

Mercury: Exposure Dose Calculations for Non-Cancer and Cancer Health Effects
North Sample Location: Duane Marine Site, Perth Amboy, Middlesex County

Assumption: north sample location, adult (70 kg), exposure duration (365 days per year for 10 years), exposure frequency (daily)
soil ingestion (100 mg/day) for homeless adults

Substance	Minimum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
mercury	0.95	100	70	1.36E-06	3.00E-04	365	10		1.94E-07	0

Substance	Maximum Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
mercury	53.1	100	70	7.59E-05	3.00E-04	365	10		1.08E-05	0

Substance	Average Concentration mg/kg	Ingestion Rate mg/day	Assumed Adult Body weight kg	Exposure Dose (Non-Cancer) mg/kg/day	ATSDR Chronic Oral MRL mg/kg/day	Duration days/yr	Duration years	USEPA Slope Factor (mg/kg/day) ⁻¹	Exposure Dose (Cancer) mg/kg/day	Excess Cancer Risk
mercury	11.37	100	70	1.62E-05	3.00E-04	365	10		2.32E-06	0

Appendix B

Duane Marine, Perth Amboy, Middlesex County

estimated blood lead increment due to site-specific exposure based on ATSDR Lead Tox Profile, Appendix D, July 1999

south sample location, children <18 years of age; time equals % of play time spent on site as opposed to play time elsewhere				
	blood lead burden in ug/dl	soil slope factor (ug/dl per ppm soil Pb)	% of play time	soil Pb conc. (ppm)
max	24.65	0.0068	0.25	14500
min	1.955	0.0068	0.25	1150
average	7.0312	0.0068	0.25	4136

north sample location, children <18 years of age; time equals % of play time spent on site as opposed to play time elsewhere				
max	17	0.0068	0.25	10000
min	1.7	0.0068	0.25	1000
average	4.518226	0.0068	0.25	2657.78

south sample location, adult homeless population; time equals 100% living time spent on the site				
max	14.5	0.001	1	14500
min	1.15	0.001	1	1150
average	4.136	0.001	1	4136

north sample location, adult homeless population; time equals 100% living time spent on the site				
max	10	0.001	1	10000
min	1	0.001	1	1000
average	2.65778	0.001	1	2657.78